

-1-

**WHAT IS CLAIMED IS:**

1. (Currently amended). A coaxial spindle cutting saw for dicing wafers and singulating substrates, comprising:

5 a spindle housing for mounting on a cutting saw for axial movement,

a coaxial spindle mounted in said spindle housing for movement therewith,

10 said coaxial spindle comprising a center spindle having first axially movable mounting means for positioning a first cutting saw blade mounted on said center spindle,

15 said coaxial spindle further comprising an outer hollow spindle mounted on said center spindle for rotation therewith and for axial movement relative thereto,

second mounting means for axially positioning a second cutting saw blade on said outer hollow spindle,

20 a spindle drive motor coupled to said spindles for rotating both said center spindle and said outer hollow spindle together at the same rotational speed,

spindle positioning means on said spindle housing coupled to one of said spindles for accurately positioning one of said cutting saw blades relative to the other cutting saw blade, and

25 whereby, said first cutting saw blade and said second cutting saw blade comprise two dicing saw blades in one spindle housing for simultaneously dicing said wafer.

2. (Previously amended). A coaxial spindle cutting saw as set forth in claim 1 which further includes a  
30 second spindle housing mounted on said same cutting saw; and  
four spindles in said two spindle housings for mounting four cutting saw blades for simultaneous cutting operations.

-2-

3. (Original). A coaxial spindle cutting saw as set forth in claim 2 wherein said spindle housings are mounted with their spindle axes mounted side-by-side and independently moveable in Y and Z axes.

5 4. (Withdrawn)

5. (Original). A coaxial spindle cutting saw as set forth in claim 1 wherein said outer hollow spindle further includes an air bearing surface between an inner diameter of the outer hollow spindle and an outer diameter of the  
10 center spindle.

6. (Original). A coaxial spindle cutting saw as set forth in claim 5 wherein said outer hollow spindle further includes an air-bearing surface on the outer diameter of said outer hollow spindle.

15 7. (Previously amended). A coaxial spindle cutting saw as set forth in claim 6 wherein said spindle positioning means further includes a voice coil actuating means mounted on said spindle housing for positioning said outer spindle relative to said center spindle.

20 8. (Currently amended). A coaxial spindle cutting saw as set forth in claim 7 wherein said voice coil actuating means further includes a moveable actuating arm slideable relative to said spindle housing, and

25 an air-bearing coupling mounted on said actuating arm for movement of said outer hollow spindle.

9. A coaxial spindle cutting saw as set forth in claim 6 wherein said spindle positioning means further includes a moveable actuating arm mounted on said spindle housing, and

30 coupling means mounted on said actuating arm for movement of said outer hollow spindle.

-3-

10. (Original). A coaxial spindle cutting saw as set forth in claim 1 wherein said spindle drive motor is directly coupled to one of said coaxial spindles.

5 11. (Original). A coaxial spindle cutting saw as set forth in claim 1 wherein said spindle drive motor is mounted in or on said spindle housing.

12. (Withdrawn)

13. (Withdrawn)

14. (Withdrawn)

10

15. (Withdrawn)

16. (Withdrawn)

17. (Withdrawn)

18. (Withdrawn)

19. (Withdrawn)

-1-

WHAT IS CLAIMED IS:

1. (Currently amended). A coaxial spindle cutting saw for dicing wafers and singulating substrates, comprising:

5 a spindle housing for mounting on a cutting saw for axial movement,

a coaxial spindle mounted in said spindle housing for movement therewith,

10 said coaxial spindle comprising a center spindle having first axially movable mounting means for positioning a first cutting saw blade mounted on said center spindle,

15 said coaxial spindle further comprising an outer hollow spindle mounted on said center spindle for rotation therewith and for axial movement relative thereto,

second mounting means for axially positioning a second cutting saw blade on said outer hollow spindle,

20 a spindle drive motor coupled to said spindles for rotating both said center spindle and said outer hollow spindle together at the same rotational speed,

spindle positioning means on said spindle housing coupled to one of said spindles for accurately positioning one of said cutting saw blades relative to the other [outer] cutting saw blade, and

25 whereby, said first cutting saw blade and said second cutting saw blade comprise two dicing saw blades in one spindle housing for simultaneously dicing said wafer.

8. (Currently amended). A coaxial spindle cutting saw as set forth in claim 7 [6] wherein said voice coil actuating means further includes a moveable actuating arm slideable relative to said spindle housing, and

an air-bearing coupling mounted on said actuating arm for movement of said outer hollow spindle.

RAZON-010

- 6 -

Figure 9 is an elevation view in section of a flange-type hub for clamping an annular ring-type saw blade between two flanges.

5                    DESCRIPTION OF THE PREFERRED EMBODIMENTS

Refer now to Figure 1 showing an isometric view of a prior art wafer dicing saw 10 having two cutting saw heads 11A and 11B each comprising a housing 12, a drive motor 13 and a cutting saw blade 14. The housing 12 is shown  
10 mounted for Y-Z support movement on the Y-Z gantry 15. It will be understood that below the saw blades 15 there will be a workstation supporting a wafer or device to be sawn. Cutting saw 10 further comprises a monitor 16 mounted on cabinet 17 which includes therein controls (not shown).  
15 The control keyboard 18 is shown mounted on the wafer handling system 19 but could have been mounted on cabinet 17. The wafer handling system 19 is shown having four stations P1 to P4. P1 is the docking station from which new wafers are taken by the robotic arm 21 and transferred to the  
20 loading station P2. After being sawn the robotic arm 21 simultaneously transfers a new wafer from P1 to P2 and the sawn wafer from P2 to the cleaning station P3. After cleaning the sawn wafer is transferred to the elevator or loading station P4 which will take it down into the system  
25 where the magazines are located.

Refer now to Figure 2A showing a schematic view of the cutting saw 10 described in Figure 1. The numerals in Figure 1 that are similar or identical to the structure in Figure 2 are the same and do not require additional ex-  
30 planation. It will be noted that the Y-Z support gantry 15 acts as a slider in the Y direction and supports the hous-

RAZON-010

- 11 -

the flux field of the actuating coils 58. Shown schematically at 53 is a spine or keyed system which allows linear motion but not relative rotational motion to the center shaft 45. It will be understood that regardless of the type of key or spine that is used, the outer moveable shaft 44 is preferably supported on an air bearing especially for high speed. However, the outer moveable shaft 44 could be supported on conventional bearings especially for low speed or singulation. Further, there is provided a water seal 54 and a water seal 55 to prevent cooling water from entering the system. A pressurized air chamber 56 may be provided to maintain an air flow at the seal 55 to guarantee that no water enters into the moving system.

It is understood that the voice coil assembly 57 moves in the Y direction with spindle housing 35 and has a Y prime linear movement as a result of the voice coil assembly moving the outer shaft 44 relative to the outer blade. Thus, it can be seen that the blade portion 14 of the modified hub 48 is capable of being moved into flush contact with each other. Further, the locking nut 51A on the inner hub is recessed in an annular recess 61 so that the flat face hub portion 49 is capable of moving into abutting relationship with other saw blade. The modified hub 48 is shown having a larger outer locking nut 51 and an adapter 52. In the preferred embodiment of the present invention the voice coil assembly 57 may be accurately positioned with an encoder 50 or a laser interferometer device RH as is known in the prior art.

Refer now to Figure 6 showing a modification of the cutting saw shown in Figure 5A and having a front saw blade 48 that is moveable by an actuating arm 41 mounted on

Marked up specification and claims showing changes made (3pp)

- 6 -

Figure 9 is an elevation view in section of a flange-type hub for clamping an annular ring-type saw blade between two flanges.

5                    **DESCRIPTION OF THE PREFERRED EMBODIMENTS**

Refer now to Figure 1 showing an isometric view of a prior art wafer dicing saw 10 having two cutting saw heads 11A and 11B each comprising a housing 12, a drive motor 13 and a cutting saw blade 14. The housing 12 is shown mounted for Y-Z support movement on the Y-Z gantry 15. It will be understood [understand] that below the saw blades 15 there will be a workstation supporting a wafer or device to be sawn. Cutting saw 10 further comprises a monitor 16 mounted on cabinet 17 which includes therein controls (not shown). The control keyboard 18 is shown mounted on the wafer handling system 19 but could have been mounted on cabinet 17. The wafer handling system 19 is shown having four stations P1 to P4. P1 is the docking station from which new wafers are taken by the robotic arm 21 and transferred to the loading station P2. After being sawn the robotic arm 21 simultaneously transfers a new wafer from P1 to P2 and the sawn wafer from P2 to the cleaning station P3. After cleaning the sawn wafer is transferred to the elevator or loading station P4 which will take it down into the system where the magazines are located.

Refer now to Figure 2A showing a schematic view of the cutting saw 10 described in Figure 1. The numerals in Figure 1 that are similar or identical to the structure in Figure 2 are the same and do not require additional explanation. It will be noted that the Y-Z support gantry 15 acts as a slider in the Y direction and supports the hous-

RAZON-010

- 11 -

the flux field of the actuating coils 58. Shown schematically at 53 is a spine or keyed system which allows linear motion but not relative rotational motion to the center shaft 45. It will be understood that regardless of the

5 type of key or spine that is used, the outer moveable shaft 44 is preferably supported on an air bearing especially for high speed. However, the outer moveable shaft 44 could be supported on conventional bearings especially for low speed or singulation. Further, there is provided a water seal 54

10 and a water seal 55 to prevent cooling water from entering the system. A pressurized air chamber 56 may be provided to maintain an air flow at the seal 55 to guarantee that no water enters into the moving system.

It is understood that the voice coil assembly 57

15 moves in the Y direction with spindle housing 35 and has a Y prime linear movement as a result of the voice coil assembly moving the outer shaft 44 relative to the outer blade. Thus, it can be seen that the blade portion 14 of the modified hub 48 is capable of being moved into flush

20 contact with each other. Further, the locking nut 51A on the inner hub is recessed in an annular recess 61 so that

x the flat face hub portion[poption] 49 is capable of moving into abutting relationship with other saw blade. The modified hub 48 is shown having a larger outer locking nut 51

25 and an adapter 52. In the preferred embodiment of the present invention the voice coil assembly 57 may be accurately positioned with an encoder 50 or a laser interferometer device RH as is known in the prior art.

Refer now to Figure 6 showing a modification of

30 the cutting saw shown in Figure 5A and having a front saw blade 48 that is moveable by an actuating arm 41 mounted on